

REMARKS

Claim 4 is amended. Claims 1-22 remain in the application. Applicants reserve the right to pursue the original claims and other claims in this application and in other applications. A petition for an extension of time is being filed concurrently herewith.

Claims 1-5, 13 and 19-22 are rejected under 35 U.S.C. § 103 as being unpatentable over Harper '326 in view of Zimmermann. Reconsideration is respectfully requested.

Claim 1 relates to a low-frequency vibration control system, with an electromagnetic actuator 76 (Fig. 1) and a digital controller 30. The actuator 76 consists of an armature 184 (Fig. 4; specification, page 4, lines 6-7; page 13, lines 24-25), a magnet coil 182 (Fig. 1) and a flux sensor 44. The actuator 76 applies forces to a controlled structure 16 (page 9, lines 29-32). The control system 30 causes a force-linearized flux to be generated in a gap 180 between the armature 184 and the magnetic coil 182, as a function of sensed vibration. The sensor 44 sends signals (64) to the controller 30 representative of the flux generated in the gap 180.

An important aspect of the invention of claim 1 is that the actuator “consist[s] essentially of an armature, a magnet coil and a flux sensor.” The phrase “consisting essentially of,” in claim 1, excludes elements that are not recited (and that would affect the basic and novel characteristics of the claimed system). See M.P.E.P. § 2111.03. In other words, the actuator recited in claim 1 consists essentially only of the armature, coil and sensor. The actuator of claim 1 is not met by actuators that have additional operational parts (see Applicants’ specification, page 4, lines 26-32).

The Office Action concedes that Harper does not disclose or suggest the actuator of claim 1. The position taken in the Office Action is that it would have been obvious somehow to use the Zimmermann actuator in the Harper system. As discussed

below, however, the Zimmermann actuator does not meet the actuator of claim 1 either. The Zimmermann actuator does not “[consist] essentially of an armature, a magnet coil and a flux sensor,” as recited in claim 1. Therefore, claim 1 should be allowable over Harper and Zimmermann, even when the two references are considered together in combination.

There are a range of electromagnetic actuators in the art, often called electromagnetic “shakers,” and in general these are devices which suspend a moving armature within an annular gap, containing a magnetic field, and current is controlled through a coil to generate forces mutually at right angles to the magnetic field and the current (Lorentz forces). In conventional shakers, the coil is the moving component, and the coil moves on a central armature. The magnetic field is generated by a stationary permanent magnet forming the outer element. Actuators have also been designed with the permanent magnet components incorporated into the armature, and the coil placed around the outside. Zimmermann is an example of the latter design. The use of flux sensors combined with commutating electrical circuits enable such actuators to be constructed with long throw, using multiple permanent magnets of alternating polarity.

An important aspect of the Zimmermann design is that a central restraint is required to maintain concentricity of the actuator components. The actuator has parts that move or slide axially relative to each other. In the Zimmermann actuator, the central restraint/concentricity for the moving parts 105 is achieved by a bore 133, a first cylindrical extension 137 located in the bore 133, an apertured plate 129, a second extension 139 extending through the plate 129, and bronze bushings 142 fitted on the first extension 137 and the plate 129. In contrast to Zimmermann, the actuator of claim 1 “[consist[s]] essentially of an armature, a magnet coil and a flux sensor.” The actuator of claim 1 does not have moving parts bushings like those of the Zimmermann actuator. The exclusion of moving actuator parts such as those in the Zimmermann device is an important aspect of the invention of claim 1. The invention of claim 1 can be employed without flexing, sliding or wearing components within the actuator to fail or malfunction. See page

4, lines 26+, of Applicants' specification (referring to prior art actuators as having "moving parts such as bearings, seals and springs that require periodic overhaul"); see also page 4, line 8-10.

Claims 2 and 3 depend from claim 1 and should be allowable along with claim 1 and for other reasons.

Claim 4 has been amended to be more clearly distinguishable over Harper and Zimmermann. Claim 4, as amended, recites, among other things, an actuator that "includes an armature, a magnetic coil, a gap located between said armature and said magnetic coil, and a flux sensor located in said gap." According to claim 4 as amended, the coil "is arranged to apply an attractive magnetic force to said armature across said gap." Zimmermann fails to meet the limitations of claim 4 as amended. In the Zimmermann actuator, the sensing device 150 is not located in a gap between an armature and a magnetic coil, across which the coil applies an attractive magnetic force to the armature.

Dependent claims 5-12 should be allowable along with claim 4, and there are other reasons why the claims should be allowable over the prior art references.

Independent claim 13 relates to a method of controlling a variable-state structure. The method includes the steps of obtaining data representative of the vibration of the structure and also "obtaining second data representative of variable mechanical characteristics of said variable-state structure." The method also includes the step of applying forces to the variable-state structure as a function of the first and second data. Harper fails to disclose or suggest the step of "obtaining . . . data representative of variable mechanical characteristics of [a] variable-state structure." Nor does Harper teach the step of "applying . . . forces to [a] variable-state structure as a function of . . . [data representative of variable mechanical characteristics]," and the Office Action provides no explanation to the contrary, and Zimmermann is cited in the Office Action for other features. These are important aspects of the invention of claim 13. Please refer, for

example, to Applicants' specification, page 3, lines 14-16. Accordingly, claim 13 should be allowable over the prior art references.

Dependent claims 14-18 should be allowable along with independent claim 13.

Independent claim 19 refers to a vibration control system that has an actuator for applying a force to a variable-state structure, a device for inputting data representative of the structure's variable state, and a processor, operatively connected to the input device and a sensor. The actuator of claim 19 includes an electromagnet, an armature and a magnetic flux density sensor. The sensor is "operatively located so as to sense the magnetic flux between said electromagnet and said armature." The sensor 150 of the Zimmermann actuator is not "operatively located so as to sense the magnetic flux between [an] electromagnet and [an] armature." The Zimmermann sensor 150 is adapted to detect the magnetic field produced by the energized coil 113, which changes as the size of the space 135 increases and decreases as the core 105 moves axially to and fro (column 4, lines 17-36). The Zimmermann actuator is fundamentally different than the actuator of claim 19, and the Office Action provides no explanation to the contrary. Harper is cited in the Office Action for a different feature. Accordingly, claim 19 should be allowable over Zimmermann and Harper even when the references are considered in combination.

Claims 20-22 should be allowable along with claim 19 and for other reasons.

Allowance of the application with claims 1-22 is solicited.

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MARK-UP VERSION SHOWING CHANGES MADE

4. (Amended) A vibration control system for a variable-state structure, said system comprising:

electromagnetic actuators for selectively applying forces to said variable-state structure, wherein at least one of said actuators includes an armature, a magnetic coil, a gap located between said armature and said magnetic coil, and a flux sensor located in said gap, and wherein said magnetic coil is arranged to apply an attractive magnetic force to said armature across said gap; and

a digital control system for operating said actuators as a function of sensed vibration of said variable-state structure, sensed vibration of a feedforward reference, and the variable state of said variable-state structure.